COAL-MINE EXPLOSIONS AND COAL- AND METAL-MINE FIRES IN THE UNITED STATES IN 1950, 1951, AND 1952

By W. J. Fene and H. B. Humphrey

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Information Circular 7661

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary
BUREAU OF MINES
J. J. Forbes, Director

Work on manuscript completed March 1953. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7661."

July 1953

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W. J. Fene[1/] and H. B. Humphrey[2/]

CONTENTS

	Page
Introduction	1
Summary and conclusions	1
Mine explosions, by States and causes	4
Causes of explosions	7
Explosion fatalities, by causes	7
Causes of explosions of electrical origin	9
Explosions in bituminous-coal mines	10
Mine fires	12

ILLUSTRATIONS

Fig.		Follows page
1.	Fatalities from gas and coal-dust explosions in all coal mines, 1880-1952	2
2.	Fatalities from gas and dust explosions in bituminous-coal mines, 1906-52	10

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INTRODUCTION

The lowest number of fatalities from coal-mine explosions in the United States in any year since records have been kept was the total of 8 in 1949 and again in 1950. Even incomplete records as far back as 1870 reveal a larger annual loss of life from explosions. From 1890 to 1948 the lowest annual loss was 32 in 1946. A smaller total of 15 fatalities was reported in 1952. Figure 1 shows the total yearly loss of life from explosions in all coal mines since 1880. Those in anthracite mines alone are shown by the shaded area.

The erratic variation of the chart line shows the difficulties that have confronted the industry in the struggle to control and eliminate mine explosions. Potential hazards have existed in many mines without realization that only a small change in conditions could initiate a disaster. Many disasters causing great loss of life occurred in mines that had been regularly operated without incident for long periods. Although the number of coal-mine explosions causing great loss of life has been kept down in recent years, the exceptions still make the record anything but satisfactory. There have been almost no widespread explosions for several years, but in a few instances many lives were lost from afterdamp. Although the violence and spread of mine explosions may be controlled, the loss of life may be heavy if many of the men happen to be in the path of the smoke and gases. For these reasons, the strictest controls must be maintained to eliminate all factors that might combine to cause even a small ignition of gas or dust.

The number of ignitions reported in 1951 and 1952 was more than the average for 1944-52. This does not indicate that more explosions are taking place, because reports are now being received of minor ignitions that were not reported in earlier years. Less than one-tenth of the explosions in the past 3 years were in mines employing fewer than 10 men.

In 1950 and in 1951 there were no fatalities from coal-mine fires. In 1952, 1 coal mine fire resulted in 4 deaths. Metal-mine fires caused 6 deaths, in 1950 and none in the next 2 years. The number of reported fires averages over 30 per year for the past 5 years. This number includes several small fires that were extinguished before they gained headway. The average number of fires shown for later years has increased because of more complete reporting.

SUMMARY AND CONCLUSIONS

1. Although progress in controlling explosion hazards in coal mines was indicated by the records for 1949 and 1950, the bad experience in 1951 proved that a great deal more has to be done before there can be any assurance that consistently low records can be expected. The total of 15

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deaths and 27 ignitions in 1952 may indicate that the hazards are better controlled than before 1948. The progress in control of loss of life from mine fires may be more substantial as there has been but 1 major disaster from coal-mine fires from 1945 to 1952; that one in 1948 took 5 lives.

2. The record of explosions from electrical causes, both in lives lost and occurrences for the past 3 years shows that earlier optimism as to improved control over electrical ignition hazards was unfounded. Some improvement in control is being made but, over all, electrical installations in coal mines are not safe.

3. In 1950, 7 of the explosions were in anthracite mines; 5 occurred in anthracite mines in 1951, and 6 in 1952. In those 3 years, explosions killed 18 men in these mines. The average number of explosions in anthracite mines for 1944-49 was 5.1, which indicates that some of the explosion hazards in these mines are not being controlled.

4. Only 8 lives were lost in coal-mine explosions in 1950, but the totals of 163 in 1951 and of 15 in 1952 show that the low records of 1949 and 1950 were exceptional.

5. The 8 fatalities in 1950 were incurred in 4 of the 18 explosions, all minor disasters. In 1951, 5 major disasters caused 157 deaths, and 5 of the 18 minor explosions caused 6 deaths. In 1952, 1 major disaster caused 6 deaths, and 3 of the 26 minor explosions caused 9 other fatalities. In 1952, 23 explosions were reported in which no men were killed, although 50 were injured.

6. In 1950, 2 explosions were ignited by open lights and 3 by smoking; in 1951, 3 were caused by open lights or torches, and 7 were either caused by smoking or may have been so caused. In 1952, 3 explosions were ignited by open flames, and 5 were chargeable to smoking. In these 3 years only 2 local ignitions were caused by open lights used for illumination. The others were ignited by defective flame safety lamps, welding torches, or smoking.

7. From 1950 to 1952, the average number of explosions of electrical origin and the resulting fatalities were as large as the averages over the preceding 9 years. Thus the hazards from present day electrical installations in coal mines are demonstrated each year. Although great care is used in some mines, much of the equipment in other mines is still unsafe from the risks of fire or explosion. Use of electricity in the mines entails such hazards that only the safest available equipment, installations, or procedures should be accepted.

8. Unsafe use of explosives caused 15 explosions and 20 fatalities from 1950 to 1952. From 1944 to 1949 an average of 7.5 explosions and 27.1 deaths was charged to this cause. This high average is due to the heavy loss of life in the Centralia disaster in 1947. The greater frequency of such ignitions since 1944 over earlier years may be accounted for by more complete reporting of occurrences. Use of nonpermissible explosives in small mines was responsible for a few such ignitions since 1950; but in most cases the men had gone outside at the time of shooting, and no one was killed. One hazard appears to be firing open shots in the presence of gas or dust. These practices were found in both anthracite and bituminous-coal mines, and safer methods should be substituted. The use of black powder or dynamite in any coal mines is dangerous, and

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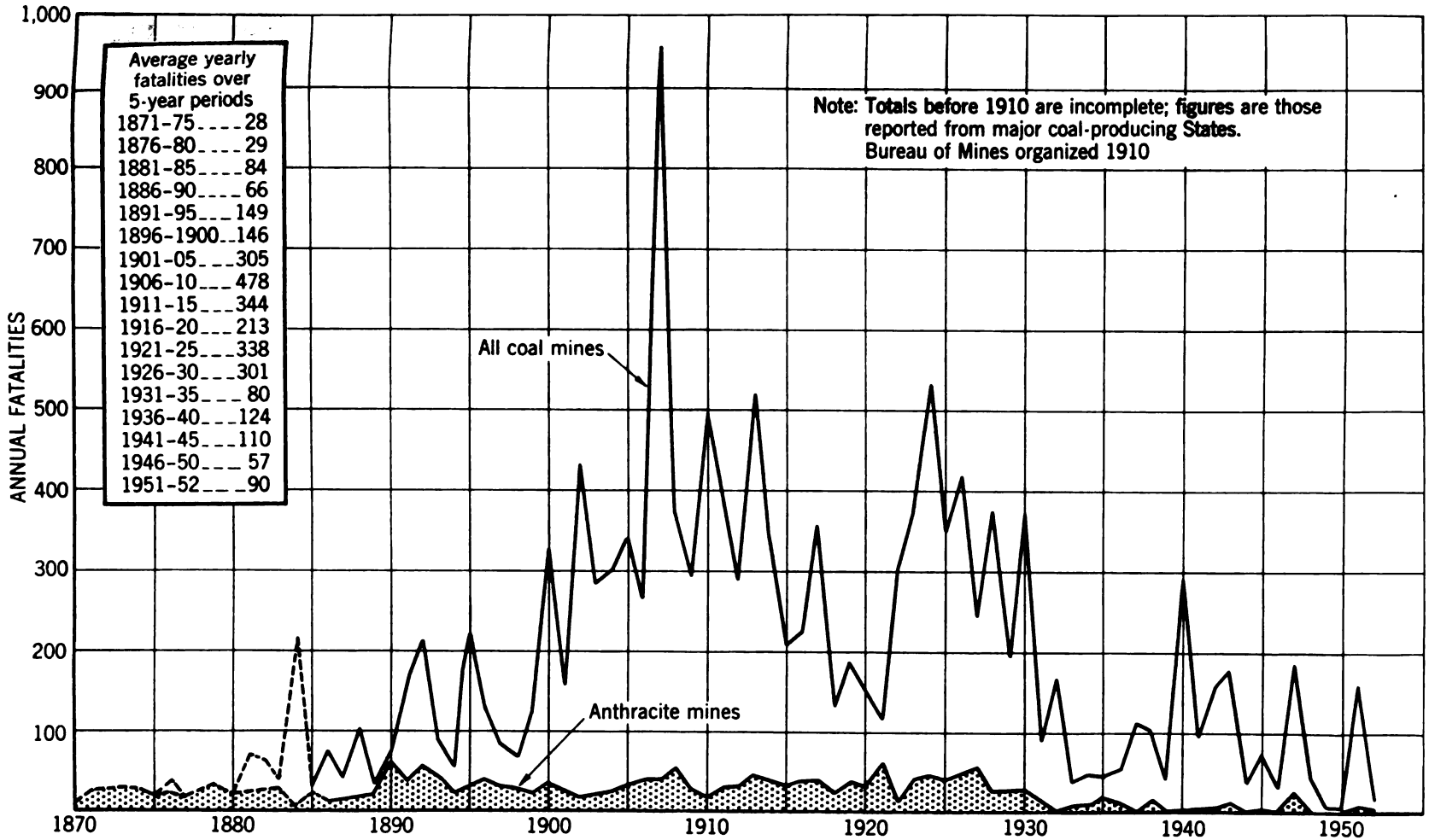

Figure 1. - Fatalities from gas and coal-dust explosions in all coal mines, 1880-1952.

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several States have outlawed its use. Permissible explosives should be used with care, since repeated explosions have shown the danger if used contrary to the permissible requirements, including maximum charge and minimum burden.

9. During the 3 years, 56 explosions were initiated by ignition of gas and 12 by ignition of coal dust. It is notable that only five of the gas explosions were spread by coal dust. In the mines where gas was ignited, ventilation was inadequate in 32 instances, in 18 others the ventilating current was interrupted or cut off, and in 6 other instances the gas accumulated in adjacent inactive workings and moved into active workings.

10. Four of the dust explosions were caused by blown-out shots or underburdened holes on the solid; 3 holes were loaded with dynamite or black powder, and 1 with permissible. Four of the explosions were caused by open shots used to break rock. In two explosions dust raised by solid shooting was ignited by current left on the firing lines. In two others, ignitions were caused by arcing from a stalled locomotive and by a welding torch. Ten of these explosions were due to unsafe blasting practices. In only six of the explosions initiated by gas was there appreciable propagation by coal dust. Even though most of the gas ignitions were small and without force the results of improved rock dusting are shown in other cases. In these 6 explosions 3 were localized by rock dust, and 3 were in mines where none had been applied.

11. The explosions that occurred from 1950 to 1952 have emphasized the need for more careful attention to thorough ventilation, closer inspection for gas that may enter from inactive places, and safeguards for blasting open shots. The maintenance of adequate rock dusting appears to have reduced the hazard from explosions by preventing their propagation by coal dust as often and as widely as in preceding years. The 12 dust explosions and 6 explosions of gas and dust show that rock dusting in coal mines has not yet reached perfection.

12. The 68 explosions during 1950-52 occurred in 10 States; in 5 of these States explosions occurred in each of the 3 years. Fatalities from the explosions resulted in five of these coal-producing States. The anthracite region of Pennsylvania had 7 explosions with 5 deaths in 1950, 5 explosions with 9 deaths in 1951, and 6 explosions with 4 deaths in 1952. In the bituminous-coal fields of Indiana and Pennsylvania, explosion fatalities occurred in 1950; the mines of Illinois, Kentucky, and West Virginia reported explosion fatalities in 1951, and others occurred in Pennsylvania and West Virginia in 1952.

13. The average number of coal-mine fires reported from 1950 to 1952 was 31. The average number for 1944-49 was 20. The increase from 1950 to 1952 has been because of more complete reports rather than more fires. Four deaths resulted from one coal-mine fire in 1952, but there were none in 1951 or 1950. Metal-mine fires in 1950 caused the loss of 6 lives, 5 being killed at 1 major disaster. In 1951 and 1952 no loss of life was reported from fires in metal mines.

14. From 1950 to 1952, 102 fires were listed in mines; 42 were of electrical origin, 13 from open lights or flames, 11 by blasting, and 36 from miscellaneous causes. Mine fires listed as miscellaneous in origin included 22 by spontaneous combustion, 11 by belt friction, and 3 of unknown causes.

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15. The only coal-mine fire that resulted in fatalities in the past 3 years was a belt fire in an average-size mine where 4 men were caught in the smoke. At a metal-mine fire 5 men attempting to reach the seat of the blaze were suffocated, and at another small fire in an abandoned mine opening 1 man was suffocated. Although only 20 coal-mine fires caused serious losses in production and property and only one caused loss of life, the frequency of fires from short-circuited power wires and from belt friction should compel attention to finding ways to control and prevent such fires. Although committees have been appointed by different safety groups to study and report on these problems, tangible results have not appeared. Some workable standards should be proposed to reduce the risks of fires from these sources. Of the reported coal-mine fires, 18 were in small mines.

16. The outstanding cause of coal-mine fires, aside from spontaneous combustion and belt friction, is overheating or short circuiting of electrical conductors. Fires frequently are caused by damage to power circuits by roof falls or contacts between equipment and power wires. If fires are not controlled quickly or men removed at once, some may be trapped or suffocated. When a fire grows beyond control much of the mine may have to be sealed and heavy expenditures made in extinguishing the fire and later reopening the area.

The fire hazards present in most mines should be recognized, and all practical measures should be taken to eliminate them. Plans and equipment should be made ready to cope with any fires that break out. A travelable means of escape for all men in the mine is of first importance.

This circular follows those of earlier years, published as Information Circulars 6178, 6419, 6540, 6680, 6771, 6819, 6870, 6927, 6986, 7048, 7092, 7136, 7208, 7274, 7330, 7359, 7456, and 7572. The information given is that revealed by investigations made by the Health and Safety Division of the Bureau of Mines. The Bureau attempts to obtain the facts concerning every explosion and most of the fires in mines in the United States. Occasionally, some less destructive mine fires or explosions are not reported to the Bureau soon enough to permit investigation, but in most instances complete details are obtained of fires or explosions in which lives are lost or property damage is more than nominal.

In recent years information has been relatively complete.

MINE EXPLOSIONS, BY STATES AND CAUSES

Table 1 summarizes the coal-mine explosions that occurred in 1950, 1951, and 1952. In 1950, 18 explosions in 6 States caused 8 deaths; in 1951, 23 explosions in 8 States cost 163 lives; and in 1952, 27 explosions in 8 States cost 15 lives.

In 1950, 14 of the 18 explosions, in 1951, 13 of the 23 explosions, and in 1952, 23 of the 27 ignitions did not result in fatalities. Mine explosions that cause five or more fatalities are considered major disasters.

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TABLE 1. - Summary of coal-mine explosions by States and causes, 1950, 1951, and 1952

State	Fatalities by causes of ignition									
	Electricity		Open lights or smoking		Explosives		Miscellaneous		Total	
	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions
1950										
Alabama	-	1	-	-	-	-	-	-	-	1
Illinois	-	-	-	1	-	-	-	-	-	1
Indiana	-	1	-	1	2	1	-	-	2	3
Kentucky	-	-	-	-	-	2	-	-	-	2
Pennsylvania.	5	3	1	3	-	2	-	-	6	8
West Virginia	-	2	-	-	-	1	-	-	-	3
Total	5	7	1	5	2	6	-	-	8	18
1951										
Arkansas	-	1	-	2	-	-	-	-	-	3
Colorado	-	1	-	-	-	-	-	-	-	1
Illinois	119	1	-	-	-	-	-	-	119	1
Indiana	-	-	-	2	-	-	-	-	-	2
Kentucky	-	-	1	1	-	-	-	-	1	1
Pennsylvania.	2	2	-	1	2	2	5	1	9	6
Virginia	-	-	-	1	-	-	-	-	-	1
West Virginia	11	5	11	2	12	1	-	-	34	8
Total	132	10	12	9	14	3	5	1	163	23
1952										
Colorado	-	-	-	-	-	1	-	-	-	1
Illinois	-	-	-	-	-	-	-	1	-	1
Indiana	-	1	-	1	-	-	-	-	-	2
Kentucky	-	1	-	1	-	-	-	-	-	2
Pennsylvania.	6	5	-	3	4	3	-	-	10	11
Utah	-	3	-	-	-	-	-	-	-	3
Virginia	-	-	-	-	-	2	-	-	-	2
West Virginia	4	3	1	1	-	-	-	1	5	5
Total	10	13	1	6	4	6	-	2	15	27

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In 1951 a major disaster in Illinois resulting in the death of 119 miners was set off by an arc from open-type electric equipment in a place where ventilation and inspection for gas had been neglected and rock dusting had been inadequately maintained. An explosion in a Pennsylvania anthracite mine killed five men when gas accumulated after a brattice was removed and was ignited by a defective flame safety lamp or other open flame. In West Virginia three major explosions occurred. In 1, 11 men were killed when gas from an abandoned area entered a working face and was ignited by an electric arc or by smoking; in another, 10 men died when gas from a pillar area was pushed into a haulageway and was ignited by an arc from a cable-reel locomotive; in a third, 12 were killed by an explosion of coal dust ignited by open shots on a rock fall that had not been rock dusted. In 1952, an explosion in a Pennsylvania bituminous-coal mine caused six deaths when gas from a squeezed, abandoned area was ignited on a haulageway by an arc from a trolley locomotive.

From 1950 to 1952, 6 minor explosions in the anthracite mines of Pennsylvania resulted in 13 deaths, and 11 other explosions caused no fatalities. In the bituminous-coal mines of that State 1 minor explosion caused 1 death and 2 others no fatalities. In West Virginia 3 minor explosions resulted in 6 deaths, 10 in no deaths. In Indiana 1 explosion caused 2 deaths; 6 were without fatalities. In Kentucky 1 explosion killed 1 man, 4 others none. Other States having nonfatal ignitions were, Alabama, 1, Arkansas, 3, Colorado, 2, Illinois, 3, Virginia, 3, and Utah, 3. The total number of injured from all reported explosions during the 3 years was 130. The injuries ranged from slight to critical.

Table 3 shows the record of explosions, by States, for the 16 fiscal years from 1929 to 1944 and for each calendar year from 1944 to 1952. In the earlier period of 16 years, 403 explosions killed 1,878 mine workers, an average of 25.2 explosions and 117.4 men killed per year. The average number of explosions for 1944-52 was 22.7, with 64.8 average yearly fatalities. In the earlier 16-year period Pennsylvania reported the largest number of explosions - 108, with 317 killed. West Virginia reported 71 with 381 deaths; Ohio had 16 explosions with 209 killed; Kentucky, Alabama, Oklahoma, and Virginia had 16 to 41 explosions and from 123 to 142 deaths. From January 1944 to December 1952 Pennsylvania reported 67 explosions with a total of 81 fatalities, West Virginia 30 explosions with 75 fatalities, Kentucky 29 explosions with 39 fatalities, and Illinois 10 explosions with 263 fatalities.

States in which no coal-mine explosions have occurred for an exceptionally long time are Wyoming, in which the last occurrence was in 1938, and Washington, which has not reported a fatality from an explosion since 1940. Coal-mining States that have not had fatalities from mine explosions in recent years are listed in table 4, which shows the year of the last explosion and the number killed.

The record of explosions and fatalities in table 3 shows that the other coal-producing States had fatalities from mine explosions in 1947 or later. Coal-producing States not known to have had an explosion during the past 24 years are Iowa, Michigan, Missouri, North Dakota, and Texas.

During the fiscal years 1929-44 an average of 4.7 deaths resulted from each explosion. For the calendar years 1944-52 the average number of deaths per explosion was 2.9. During these 9 years Illinois shows an average of 26.3 deaths per explosion, New Mexico, 6, and Oklahoma, 5.

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The averages of the other States are lower. The only significance of the figures is to show the high average of fatalities in States having few minor ignitions but one or more major disasters.

CAUSES OF EXPLOSIONS

During the fiscal years 1929-44, shown in table 2, 403 explosions were studied, of which 179, or 44.4 percent, were caused by electricity. From 1944 to 1952 85 of a total of 204 ignitions, or 41.7 percent, were from this cause. Thirteen such explosions occurred in 1952, 10 in 1951, 7 in 1950, and an average of 9.5 for 1944-52. Open lights and smoking were given as the cause of 135 (33.5 percent) of the explosions recorded from 1929 to 1944. These 2 causes were responsible for about 74 percent of the known explosions during those 16 years. From 1944 to 1952, 64.7 percent of the ignitions were from these 2 causes, 41.7 percent from electricity, and 23.0 percent from smoking and open lights. This indicates that the hazard from electricity is increasing, wheras that from open lights is less. Despite the indicated improvement, smoking in gassy mines has been noted and caused ignitions from 1950 to 1952. Smoking must be iluminated, use of open-type electric equipment must be curtailed, and the ventilating systems must be changed and improved before the frequency of explosions can be reduced further.

Fifteen explosions, resulting in 20 deaths, were caused by unsafe blasting practices from 1950 to 1952. The average for 1944-52 was 6.7 explosions and 20.3 deaths. The averages for 1929-44 were 3.6 explosions and 19.9 deaths. It may be that more of the nonfatal ignitions of this type are being reported in later years. From 1950 to 1952, 7 explosions from open blasting in the presence of gas were reported from anthracite mines; 4 explosions from open shots occurred in bituminous-coal mines. Six explosions were charged to shooting on the solid, 3 of these using black powder.

EXPLOSION FATALITIES, BY CAUSES

As shown in table 2, 1,878 men were killed by explosions in the fiscal years 1929-44, and 583 were killed from 1944 to 1952. Explosions of electrical origin caused 1,067 (56.8 percent) of the fatalities in the 16-year period and 326 (55.9 percent) in the last 9 years. The average number of deaths from explosions of electrical origin from 1950 to 1952 was 49. The average for 1944-52 was 36.2. The hazard from electrical ignitions of gas and dust has not been controlled or reduced to any reasonable degree, and the present conditions should not be accepted as satisfactory or normal to safe mining practice. Only the safest types of electrical equipment should be used in coal mines and then only with adequate maintenance and effective ventilation of all working places.

One death was caused by an explosion from open lights or smoking in 1952, 12 from such explosions in 1951, and 1 in 1950. These compare with an average of 24.9 deaths in the fiscal years 1929-44 and 3.5 for 1944-52. Except for 1951, table 2 shows fewer explosions from these causes since 1944 than in the years 1929-44. Most of these explosions and fatalities were chargeable to smoking in gassy mines. The number of mines in which open lights are used has dwindled to a few, but smoking is noted in many mines where gas has been found. Both open lights and smoking should be eliminated from coal mines.

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TABLE 2. - Summary of explosions, by causes, 1944-52

Years	Fatalities, by causes of ignition: Electricity		Open lights or smoking		Explosives		Miscellaneous		Total	
	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Death	Ignitions	Deaths	Ignitions
1944	30	11	4	6	3	7	2	3	39	27
1945	40	14	3	5	16	9	23	1	82	29
1946	13	5	2	5	17	4	-	-	32	14
1947	64	9	5	5	121	8	-	1	190	23
1948	29	12	3	4	3	11	11	2	46	29
1949	3	4	-	2	3	6	2	2	8	14
1950	5	7	1	5	2	6	-	-	8	18
1951	132	10	12	9	14	3	5	1	163	23
1952	10	13	1	6	4	6	-	2	15	27
9-year total.	326	85	31	47	183	60	43	12	583	204
Average	36.2	9.2	3.5	5.2	20.3	6.7	4.8	1.3	64.8	22.7
Fiscal years 1929-44	1067	179	398	135	318	58	95	31	1878	403
Average	66.7	11.2	24.9	8.4	19.9	3.6	5.9	1.9	117.4	25.2

TABLE 3. - Record of explosions, by States, total fiscal years 1929-44 and for calendar years 1944-52

States	1929-44		Average		1944		1945		1946		1947		1948		1949		1950		1951		1952		1944-52 Total		Average		Deaths per ignition
	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	
Alabama	123	41	7.7	2.6	2	3	3	1	2	1		1	11	1	-	-	-	1					18	8	2.0	0.9	2.2
Alaska	14	2	.9	.1																							
Arkansas	41	17	2.6	1.1	3	1							10	2		1			-	3			13	7	1.4	.8	1.9
Colorado	59	15	3.7	.9		1			1		-	1							-	1	-	1	-	5	-	.5	-
Illinois	85	18	5.3	1.1	1	1	-	1	-	1	141	3	-	1			-	1	119	1	-	1	263	10	29.2	1.1	26.3
Indiana	72	12	4.5	.8	1	2			-	1	11	3	13	2			2	3	-	2	-	2	27	15	3.0	1.7	1.8
Kentucky	135	22	8.4	1.4	3	3	29	6	-	1	1	4	2	7	3	3	-	2	1	1	-	2	39	29	4.3	3.2	1.3
Maryland	1	1	.1	.1									3	1									3	1	.3	.1	3.0
Montana	74	1	4.6	.1										1									-	1	-	.1	
New Mexico	22	4	1.4	.3	6	1																	6	1	.7	.1	6.0
Ohio	209	16	12.4	1.0	-	1					1	1											1	2	.1	.3	.5
Oklahoma	142	21	8.9	1.3	1	1	9	1															10	2	1.1	.3	5.0
Pennsylvania ..	317	108	19.8	6.6	3	8	7	9	2	2	35	6	4	9	5	8	6	8	9	6	10	11	81	67	9.0	7.4	1.2
Tennessee	13	11	.8	.7			1	1															1	1	.1	.1	1.0
Utah	32	6	2.0	.4			31	3			-	1									-	3	31	7	3.4	.8	4.
Virginia	129	16	8.1	1.0	2	1	1	2	13	4	1	1	-	1	-	2			-	1	-	2	17	14	1.9	1.6	1.2
Washington	21	19	1.3	1.2	-	1	-	1	-	2													-	4	-	.4	
West Virginia .	381	71	23.8	4.4	17	3	1	4	15	1	-	2	3	4			-	3	34	8	5	5	75	30	8.3	3.3	2.
Wyoming	8	2	.5	.1																							
Total	1878	403	117.4	25.2	39	27	82	29	32	14	190	23	46	29	8	14	8	18	163	23	15	27	583	204	64.8	22.7	2.

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TABLE 4. - States without fatalities from explosion in recent years

State	Last fatal explosion		Number, years to 1952
	Year	Number killed	
Alaska	1937	14	15
Wyoming	1938	5	14
Washington	1940	1	12
Colorado	1943	1	9
Montana	1943	74	9
New Mexico	1944	6	8
Oklahoma	1945	9	7
Tennessee	1945	1	7
Utah	1945	31	7
Virginia	1947	1	5

TABLE 5. - Electrical causes of explosions, fiscal years 1929-44, calendar years 1944-1952

Type of equipment	1929-1944	1944	1945	1946	1947	1948	1949	1950	1951	1952	Total 1944-52
Locomotive (Nonpermissible)	47	3	5	2	1	2/5	-	5	3	6	30
Mining machine	40	2	1	-	2	3	1	-	3	1	15
Rock dusting											
Loading machine	-	-	-	-	-	-	-	1	-	-	1
Drill (Nonpermissible)	19	-	1	1	-	2/1	-	-	1	1	7
Cable or nip	7	-	3	2	2	-	-	-	1	1	9
Motor, hoist, etc.	17	-	1	-	2/2	1	2/2	-	-	-	6
Wire or circuit	17	-	2	-	-	1	1	1	2	4	11
Unclassified arc	32	2	1	-	2/2	1	-	-	-	-	6
Total	1/179	11	14	5	9	12	4	7	10	13	85

1/ Explosions of possible electrical origin not included, under locomotive-2, mining machine-2, wires or circuit-2.
2/ One or more charged to electricity may have been due to smoking.

From 1950 to 1952 an average of 6.3 deaths resulted from explosions caused by unsafe use of explosives. The total of deaths for 1944-52 was 183, an average of 20.3 per year, and for 1929-44 the average was 19.9. The high average in recent years is due to the disaster at the Centralia mine in Illinois in 1947, when 111 lives were lost. The number of fatalities from this type of explosion has varied greatly from year to year; but the recurrence of the explosions, with small or great loss of life, shows that dangerous blasting practices are followed in many mines. The danger may often be unrealized, since the same practices may be used for a long time before an explosion results. Those from use of black powder and solid shooting are not unexpected, but deviations from recommended safe practices with permissible explosives should also be examined to make certain that a hazard is not being introduced.

CAUSES OF EXPLOSIONS OF ELECTRICAL ORIGIN

The types of electrical equipment that caused ignitions and the number of ignitions attributed to each type during the fiscal years 1929-44 and the

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calendar years 1944-52 are shown in table 5. In the earlier 16 years at least 179 explosions, with 1,067 fatalities, were reported to be of electrical origin. During the last 9 years, 85 explosions, probably originating from electric arcs, caused 326 deaths.

Locomotives and mining machines were charged with originating over half of the explosions of electrical origin from 1944 to 1952. Most of this equipment was of nonpermissible type, but in a few of the explosions permissible equipment improperly maintained was held to be the source. From 1950 to 1952 14 explosions were charged to locomotives, 4 to mining machines, 1 to a rock-dusting machine, 2 to drills, 2 to cables or nips, and 7 to power wires or switches. None were charged to open-type motors or controls during the 3 years. The principal contributing factors in these explosions were: Failure to test for gas before taking equipment into working places or before putting it in operation or during operation and failure to provide and maintain adequate continuous ventilation where electrical equipment is operated.

The rapid increase in mechanization of coal mines brings more electrical equipment into use each year. Since the number of explosions initiated by electricity has not increased, some definite benefits are being shown from improved safety standards, such as adequate ventilation, testing for gas, and restricting the use of nonpermissible electric equipment. Although electrical ignitions have not increased in number they have not been reduced in frequency, and much more remains to be done.

EXPLOSIONS IN BITUMINOUS-COAL MINES

The trend of total annual fatalities from gas and dust explosions in bituminous-coal mines of the United States during the calendar years 1906-52 is shown in figure 2. The reduction in explosion fatalities between 1907 and 1921 was reversed by the bad records of 1922-24. From 1924 to 1935 good progress was made again for which some credit must have been due to the combined safety programs conducted in the industry. Since 1936 the record has been erratic, with a high total of fatalities in 1940 and low totals in 1949 and 1950. The rapid changes in mining methods and practices probably have affected the efforts to control explosion hazards. It is characteristic of the record as shown on the chart that a bad disaster or series of disasters in one year causes renewed and greater attention to preventive measures that makes the next year's total much lower. The potential elements of coal-mine explosions, gas, dust, and an igniting spark cannot be eliminated from the mines, but their combinations can be eliminated and controlled so that explosions do not occur.

The average yearly fatalities from explosions for 5-year periods are shown in figure 2 from 1906 to 1910 through 1946 to 1950. The average of 438 for the years from 1906 to 1910 indicates one of the main reasons for which the Bureau of Mines was formed. This average was reduced by one-fourth from 1911 to 1915 and by almost two-thirds in the next 5 years. An increase to a yearly average of 296 for the period 1921-25 was followed by a drop to 65 in the next 10 years. Between 1936 and 1945, the averages were 115 and 102, dropping to a low average of 47 for the years 1946-50. The experience of 1933-36, 1944, 1946, 1949, 1950, and 1952 is evidence that the loss of life from explosions can be made much lower than many experienced coal-mining men have thought possible.

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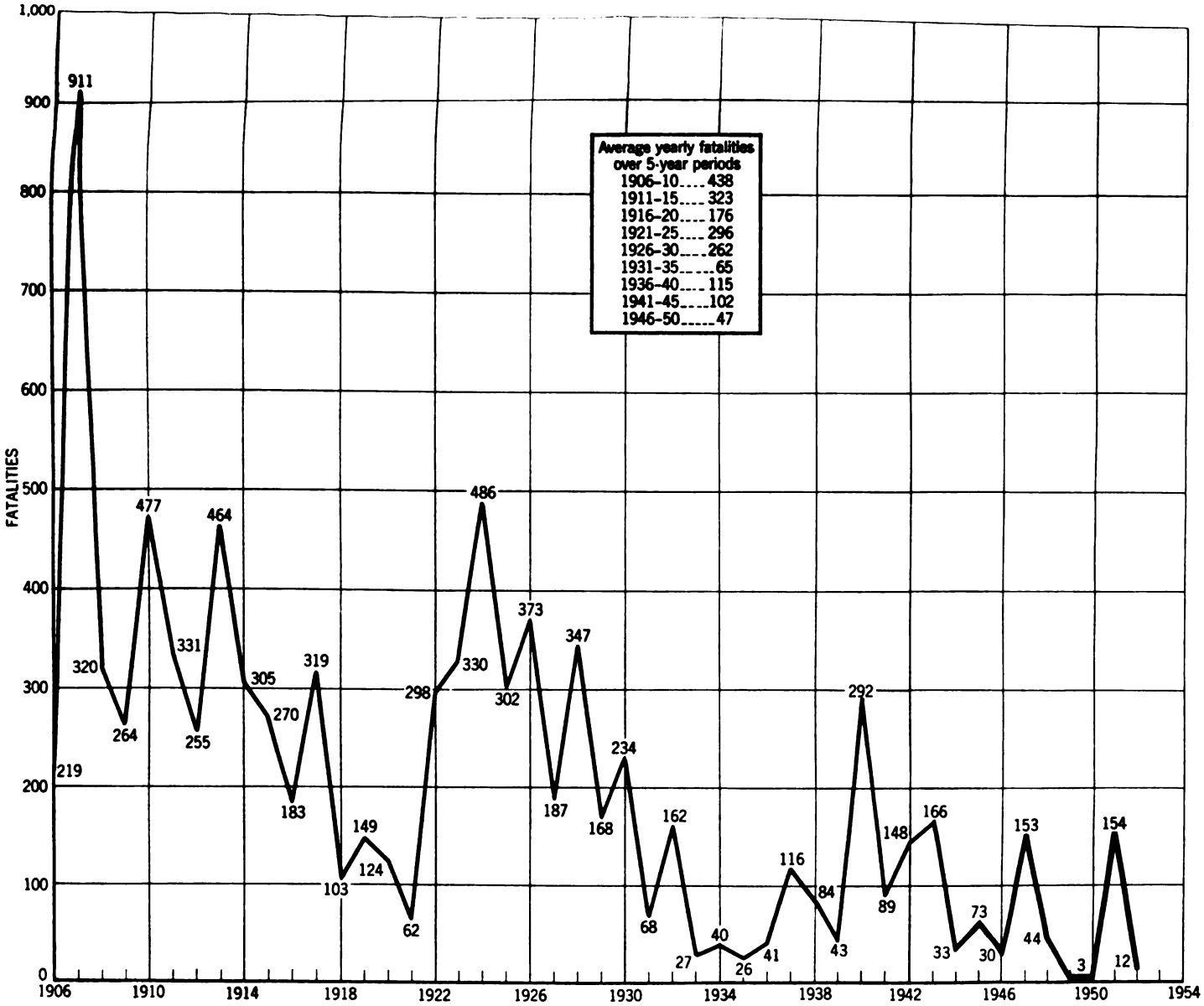

Figure 2. - Fatalities from gas and dust explosions in bituminous-coal mines, 1906-52.

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Records can be consistently low when a majority of the mine operators, mine workmen, and officials who are responsible for enforcement of mine-safety laws refuse to tolerate explosion hazards in coal mines. Regulations or safe practices necessary to prevent explosion cannot be put into effect by any single group of those mentioned, but the desired result can be attained by cooperation and agreement. The primary step must be acceptance by all concerned of the concept that mine explosions are not a "trade risk" and that the rigid preventive measures necessary are practicable and desirable. There is some evidence that this concept is gaining ground and that major explosion disasters are not regarded as unpreventable.

The Federal Coal Mine Safety Act (Public Law 552, 82d Congress, July 16, 1952) affords limited enforcement powers to the Federal coal-mine inspectors with respect to certain safety provisions that might cause or lead to major disasters in coal mines employing 15 or more men underground. The law specifically directs that mines in which 0.25 percent or more of methane is found shall be operated under the rules governing gassy mines; that ventilation must meet prescribed standards; that examinations must be made for hazards before persons other than the examiners enter; and that during each shift men shall be withdrawn if the concentration of methane exceeds 1.5, or 2 percent, under stated conditions; that coal dust shall not be allowed to accumulate or be carried in the air current; that rock dust shall be applied and maintained adequately to within 40 feet of all faces; and that electric equipment, with certain exceptions, shall be permissible. The use of black powder is prohibited, and in bituminous-coal mines open shots may not be fired.

The adoption and observance of these regulations should eliminate most of the chances of explosions and many causes of mine fires. Cooperation and joint inspections by State and Federal mine inspectors should lead to substantial improvement in preventing fires and explosions.

The hazards that contributed to explosions from 1950 to 1952: (1) Failure to provide and maintain continuous ventilation and to prevent movement of gas accumulations from unventilated areas into working sections, 45 instances; (2) use of open-type electric equipment without providing constant adequate ventilation to prevent accumulation of explosive mixtures, 26 instances; (3) failure to test for gas before or while working in areas where methane might be liberated, 21 instances; (4) unsafe methods of blasting, including the use of nonpermissible explosives, 16 instances; (5) smoking or use of open flames in mines, 19 instances; (6) inadequate rock dusting, permitting initiation or propagation of an explosion, 13 instances; (7) damaged or improperly adjusted flame safety lamps, 3 instances.

All of the foregoing unsafe practices or conditions have been listed in earlier reviews as the causes of explosions in those years. In a few of the explosions from 1950 to 1952 failure to rock dust adequately allowed explosions to develop into major disasters, although it is also a fact that in more instances the rock dusting was good so that the explosion was limited to a small area. This hazard is gradually being reduced. Disturbing factors are: Ventilation is not controlled closely in face sections, tests for gas are not made before electrical equipment is moved or operated; and smoking and careless blasting continue.

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MINE FIRES

From 1950 to 1952 the Bureau of Mines received reports of 92 coal-mine and 10 metal-mine fires. Four deaths were caused by 1 fire in a coal-mine and 6 by 2 fires in metal mines. The fire in the coal mine was caused by friction of a drive pulley against a stalled belt. One metal-mine fire costing 5 lives was of electrical origin in a shaft station; cause of the other was unknown. Few lives are lost in mine fires, except in great disasters when many are trapped. Controlled ventilation, additional escapeways, prompt removal of men, and orderly action to control fires before they spread have all helped to keep down fatalities as well as to reduce the damage and loss to the mines.

Table 6 lists the fires reported for 1952. Eight were in West Virginia, 5 in Kentucky, 4 in Utah, 2 each in Pennsylvania and Colorado, and 1 each in Indiana, New Mexico, and Ohio. Surface fires that destroyed tipples, plants, shops, and other structures but did not affect the mine workings are not listed in table 6. Small fires underground involving only mining machines or other equipment are excluded also.

The hazards indicated by the fires from 1950 to 1952 are poorly installed and maintained electric equipment, unsafe installation and control of belt conveyors, and spontaneous combustion. Another source of repeated fires is contact between trolley or power wires and rails caused by roof falls.

Table 7 lists the mine fires recorded since 1929, with their causes. Before 1944 most of the fires are listed as being in open-light mines; but since that time, the proportion of mines using closed lights has grown to such a preponderance that few fires are now listed from the small mines using open lights. The number of fires of electrical origin is still larger than those from other causes. The average for 1944-52 has been 13 per year. The number of fires from open flames and smoking averaged 3.4 and from explosives 3.3. Under miscellaneous, averaging 8.6 fires a year, are included those from spontaneous combustion, belt friction, and unknown causes.

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TABLE 6. - Summary of mine fires, by States, 1952

State	Fatalities, by cause of ignition											
	Lighting used		Electricity		Open flame		Explosives		Unknown or miscellaneous		Total	
	Open	Closed	Deaths	Fires	Deaths	Fires	Deaths	Fires	Deaths	Fires	Deaths	Fires
Coal mines:												
Colorado	-	2	-	-	-	-	-	-	-	2	-	2
Indiana	-	1	-	1	-	-	-	-	-	-	-	1
Kentucky	-	5	-	2	-	1	-	-	4	2	4	5
New Mexico ...	1	-	-	-	-	-	-	-	-	1	-	1
Ohio	-	1	-	1	-	-	-	-	-	-	-	1
Pennsylvania .	2	2	-	1	-	1	-	-	-	2	-	4
Tennessee	-	2	-	-	-	1	-	-	-	1	-	2
Utah	-	3	-	-	-	1	-	-	-	2	-	3
West Virginia.	-	8	-	5	-	-	-	-	-	3	-	8
Total coal-mine fires	3	24	-	10	-	4	-	-	4	13	4	27
Metal mines:												
Utah	-	1	-	-	-	1	-	-	-	-	-	1
Total	3	25	-	10	-	5	-	-	4	13	4	28

TABLE 7. - Summary of mine fires, by causes, fiscal years 1929-44 and calendar years 1944-52

Year	Lighting used			Electricity		Fatalities, by cause of ignition								
						Open lights		Explosives		Unknown or miscellaneous		Total		
	Open	Closed	Unknown	Deaths	Fires	Deaths	Fires	Deaths	Fires	Deaths	Fires	Deaths	Fires	
Fiscal years 1929-44	130	100	126	53	112	10	19	5	37	54	188	122	1/356	
Average, 16 years...	8.1	6.3	7.9	3.3	6.9	0.6	1.2	0.3	2.3	3.4	11.8	7.7	22.3	
1944.....	5	29	-	75	23	2	3	-	3	2	5	79	34	(10 metal)
1945.....	6	14	-	-	9	-	2	1	5	-	4	1	20	(4 metal)
1946.....	11	12	-	-	7	-	7	-	1	-	8	-	23	(4 metal)
1947.....	3	15	-	1	9	-	1	-	1	-	7	1	18	(3 metal)
1948.....	8	13	-	2	10	-	3	-	2	6	6	8	21	(5 metal)
1949.....	11	27	-	4	17	-	3	-	7	-	11	4	38	(8 metal)
1950.....	9	27	-	5	16	-	4	-	5	1	11	6	36	(4 metal)
1951.....	8	30	-	-	16	-	4	-	6	-	12	-	38	(5 metal)
1952.....	3	25	-	-	10	-	5	-	-	4	13	4	28	(1 metal)
9-year total.....	64	192	-	87	117	2	32	1	30	13	77	103	256	(44 metal)
Average 9 years.....	7.1	21.3	-	9.7	13.0	0.2	3.4	0.1	3.3	1.4	8.6	11.4	28.4	

1/ Includes 55 metal-mine fires and 12 outcrop fires.

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